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ABSTRACT

This paper discusses changes in educational content and methodology brought about in response to the needs of the present technology-driven information age. The use of word processing, databases, and spreadsheets is explained in relation to the promotion of higher order thinking skills. The increased amount and graphic nature of information as well as the increased role of the media center are discussed. The proper infusion of technology into education is seen as a slow evolutionary process for the following reasons: (1) the development of technology itself is an evolutionary process; (2) the cost of technology overburdens educational budgets; and (3) it takes time to implement programs and provide inservice. Nine strategies to overcome the obstacle of costs are listed. Because this is a technological age, new or revised curricula should include the use of appropriate technology that will help students learn how to learn. (JD)

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(Learning, Information, Technology, Evolution For Improved, Revitalized, Education)

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L.I.T.E. the F.I.R.E.

(Learning, Information, Technology, Evolution - For Improved, Revitalized Education)

Robert J. Rodgers

Modern society places different demands on the educational system than it did during the past industrial era. As stated in the 1989 ASCD yearbook, "What all literate citizens should know will no longer be a major concern. It is not possible to predict exactly the knowledge base required of productive citizens in the global/service-oriented/information age." Home computers, home banking, the office at home, cellular phones, fax machines, modems, CD players, high definition TV, computerized data bases and services, and library networking are current realities. They have become integral components of our society and need to be addressed by our educational system to provide a new breed of "literate" citizenry. Technology and society's dependence on information has impacted on learning in an evolutionary manner, providing both the impetus and the means to revitalize and improve our educational system.

Learning

In light of the technology driven information age in which we now live, we must examine both what and how our students learn. Higher-order thinking skills, critical thinking, computer literacy, problem-solving and cooperative learning were highly touted educational "buzz words" of the 1980's. Influential educational bodies such as the National Council of Teachers of Mathematics and the American Library Association have formalized visions and provided guidance in bringing today's education closer to the society's needs in the 1990's and the 21st century.

Recent research aids our understanding of how to educate the human brain in our electronic society. Sylwester(1990) proclaims, "We need to create curriculums based on the complementary relationship between the human mind and the machines we develop to supplement our capabilities." He states, "New technologies have always emerged out of the limitations and interest of the brain's sensory/motor and problem-solving mechanisms - narrowing the distance between what we can do and what we would like to do." Typewriters, telescopes, microscopes, and calculators are four technologies that have been developed to gather/process/interpret/use information.

After many years of disapproving the use of calculators, mathematics educators have now accepted their role as tools in mathematics education. Moreover, not only are they now accepted, but the use of the calculator is being strongly advocated. The N.C.T.M.(1989) "Standards" promote the use of calculators as a necessary, not optional, component of the recommendations. In New Jersey, the state mandated test for graduation: "High School Proficiency Test" has been revised for 1991 with the use of the calculator in mind. Plans call for the use of the calculator as soon as the State is assured that all students will have calculators available. Educational Testing Service promises that the S.A.T. will allow the use of the calculator within the next four years. Kinnaman(1990) quotes Dr. Judah Swartz of Harvard's Educational Technology Center, "With the current pace of hardware and software development, and with our increasing knowledge of cognition and learning, 'it is immoral for us to spend 200 hours teaching someone to be a poor imitation of a five-dollar calculator' ."

Sylwester(1990) argues that curricula should focus on teaching students how best to use appropriate technologies on tasks that characterize the brain's limitations. He further states, "The human brain is currently much better than computers at conceptualizing ambiguous problems - at identifying definitive and value-laiden elements it can incorporate into an acceptable general solution. Conversely, computers are much better at rapidly, accurately, and effectively processing complex sequences of clearly defined facts and processes that would otherwise require a high level of mental attention and precision." An important aspect of infusing the use of technology into the curriculum needs to be the consideration of what technologies are appropriate and when such use is effective, more interesting and efficient.

Kelly(1990) states, "The revolution in office and manufacturing technology has also redefined the nature of the basic skills needed for success in America." He points out that the "quick comprehension of written materials and the ability to speak and write clearly are essentials for virtually all jobs created by an information - intensive economy." New jobs often require new skills and use of new technologies. Marshall(1990) states, " We can no longer behave as though we are educating future workers for the assembly line. U.S. life is changing. A technological society is replacing the farms and factories. It is becoming more important to adapt to constant change than to perform repetitive actions. In the 21st century, U.S. workers must meet challenges and solve problems." Workers in occupations that do not require college degrees are being placed in the position of using new technologies. Auto mechanics are using computerized diagnostic machines and computer data bases. Most office workers use computers, fax machines and computerized communications systems on a regular basis. Some restaurants use computerized systems for the waitresses and cooks.

The use of the computers promotes higher order thinking skills. The use of the word processor encourages analysis and evaluation by streamlining the mundane tasks of rewriting and editing. Most spelling checkers identify words not in their word banks and force the user to make decisions about spelling. The use of databases, with the efficient storage and retrieval of data, decreases our reliance upon memorization. This promotes development of search strategies, organizational skills, evaluation of information, making hypotheses, and making conclusions and decisions. The use of spreadsheets allows the user to see data organized and calculated in a manner that lends itself to analysis and evaluation. The lower level skill of calculating is done for the user, but the user is forced to develop formulas, functions and models. The "what-if" feature of a spreadsheet leads to prediction, analysis, evaluation, and conclusion. Cronin(et al 1990) states, "Using highly structured computer programs, students learned to construct visual maps representing the relationships of major ideas, subordinate ideas, and explicit information." The efficient and effective use of the computer becomes a skill, a skill that involves higher level thought processing than most traditional methodologies.

Molnar(1990) explains how Dr. Seymour Papert has "created a new school of thought on the role of computers in education - Constructionism. He accepts the view that learning is a reconstruction rather than a transmission of knowledge, and extends this idea by postulating that the most effective learning takes place when it is part of an activity the learner experiences while creating a meaningful product."

The use of computers tends to encourages cooperative learning. In settings where there are more students than machines, group work becomes the necessary mode. Using cooperative learning strategies assures equal access and equal learning opportunity. Even where each student has a computer available, students tend to help other students. The benefits in developing mutual cooperation and improving self-esteem are very evident. This is consistent with Toffler (1990), who suggests the present and future workplace demands shared decision making and teamwork. Marshall(1990) explains, "Americans must realize that the assembly-line model of education, with each student working alone toward mastery of an isolated task, doesn't fit industry's needs for the 21st century. Collaboration is the key, both on the job and in the classroom. Problem solving thrives in cooperative settings."

Molnar (1990) states, "National commissions have elevated computing to the position of a new basic skill - on par with reading, writing, and arithmetic." He explains that many colleges and universities require incoming students to own a computer. He explains support for the notion of students having computers available in stating, "Two-thirds of the universities provide financial assistance to help students acquire them."

The increasing use of technology, and the evolution of technology, requires that learning be an on-going requirement. Many present educators need to increase their use and application of technologies. The use of word processing for lesson plans and production of instructional materials should be a given. As stated by Luehrmann (1990), "Isn't the school's business the organization and presentation of information of all kinds to all students ?" However, the reasonable availability of computers and wordprocessing software is not a given. In addition to supplying equipment and training for our students, we must provide conveniently available hardware, software and inservice to our staffs. Computerized attendance and grading programs can accomplish mundane tasks more efficiently and provide educators more time to concentrate on the instructional process.

To improve our educational systems, we must consider that technology provides the means to provide instruction in a more effective, interesting and efficient manner. The content of our instruction needs to include the use of technology. We must recognize that the evolution of technology will continue and the need to learn with and about technology is on-going. This applies both to students and educators.

Information

Computer ads state that the amount of information doubles every 2 years. This means that by the time today's kindergartners graduate from high school, the amount of information will have increased sixteen-fold. Computer data bases make so much information quickly available that we need to concentrate on retrieving the information that we need without being inundated with irrelevant information. Naisbitt (1982) contends, " We are drowning in information but starved for knowledge." He explains further, "The emphasis of the whole information society shifts, then, from supply to selection. This principle is the driving force behind the new electronic publishers who provide on-line data bases, communication channels for sorting through and selecting. These new businesses are selling a medium, not information as such."

Information is more than just the printed word. In our fast-pace society, graphical information is becoming more popular. The old adage, " a picture is worth a thousand words", is making its mark! The use of international traffic signs decreases our dependence on the written word. Colorful graphs are becoming as common as spreadsheet outputs. Mathematics education now is now stressing data analysis, including the interpretation of graphs.

In computers, the graphical user interface is becoming the norm. Following the success of the Macintosh, Microsoft's Windows is bringing the graphical user interface to the MSDOS environment. In a trade magazine, Davies(1990) states, "If value-added-resellers do not make the move to the graphical environment now, in 12 to 18 months, they are not going to be competitive." This is for a good reason - it's easier to train customers using a graphical user interface (GUI). Users with GUIs are more self-sufficient and more efficient. According to Davies(1990), a study by a consultant firm hired by Microsoft and Zenith found the following results: "Novice users on a GUI system tried 23 percent more new tasks that users on character-based systems " and "workers on GUI systems were 58 percent more productive than workers on character-based systems."

The increased size and lower costs of data storage devices, including CD technology, have permitted multi-media to become an affordable reality. Desktop publishing has made it possible to produce pamphlets, flyers and reports of excellent quality at reasonable costs and in a timely manner right in the office. This ability now includes color capabilities.

The enormous amount of information and variety of formats (books, audio tapes, VCRs, CDs, computer disks and cartridges, etc) has put an over-whelming burden on libraries to provide up-to-date services. One way that libraries are addressing this task is to use the technology that has created the "problem". Libraries across New Jersey are "networking" to pool and share their resources. In this way, their collective efforts far exceeds the individual capabilities.

If education is to focus on the processing and interpreting of data, the school's media center takes on an increased role. This needs to be addressed with expenditures, scheduling, staffing and in-service.

To improve our educational systems, we must address the needs of improving how we make information available. This includes using more modern formats of presenting information and the recognition of multiple forms of information, especially graphics. Television has enhanced the information provided by radio and fax machines have added graphics to telephone communications.

Technology

The evolution of technology has accelerated to the point that there is little hope of most educational institutions coming close to "keeping up." However, we must realize that the technology has surpassed our current educational needs. An essential strategy is that we continue to move in the direction of the available technology. Ten years ago many computer education programs in the K-12 environment taught computer programming primarily because most computers that were in the schools at that time were of the 64 K, 40 column display, poor graphical quality variety. Now that 80 column displays are the norm, word processing should be an integral part of the writing process, and at an early age. With good quality color displays, work in the graphical environment can be readily available. Computer software can be more sophisticated now that most microcomputers come with at least 1 megabyte of memory. Kinnaman(1990) explains how Dr. Seymour Papert and the MIT Media Lab have developed "a matchbook-size computer, equivalent to the power of an Apple II, that resides within a LEGO brick."

Technology has shrunk the time necessary to distribute information. As efficient as the Pony Express was, the telegraph quickly made that means of information distribution obsolete. Today, telecommunications, cellular phones, radio and TV make information available instantaneously.

The increased promotion of calculators in education has occurred as the capabilities of calculators have increased. A simple calculator can be purchased for less than $ 5.00. Advanced calculators, such as the Texas Instrument Explorer, can handle fractions and mixed numerals. Others offer graphing and programming capabilities.

With larger memories and storage devices, most interactive computer programs are menu-driven. Menu-driven software emphasizes the selection of available functions, not the rote memorization of "key words" and commands. In terms of learning, Sylwester(1990) states, "Recognition is easier than recall." The larger capacities also allow for more manipulation of graphical information. At a recent seminar, Goodman explained how the Whale Song book incorporated high technology scanners and color laser printers into its production to save time and to put more control in the hands of the "artist". Home videos are popular now that VCR technology is reasonably affordable. Schools now are able to infuse this technology as modern "A-V" equipment.

A recent visit to a local 2-yr community college (Brookdale Community College, Lincroft, New Jersey) to tour their newly constructed "Technology Center" revealed the following technological training areas:

1. Computer-Aided Manufacturing
2. Computer Lab with specialized equipment for the handicapped
3. Robotics
4. Computer-Aided Design Lab
5. Computerized TV studio and control room
6. Computerized Video Distribution center
7. Computerized Audio studio and control room
8. Computerized Music lab
9. Computerized Telephony
10. Training room for IBM mid-sized computer
11. General-purpose computer labs

This is a rather impressive list for a community college. Last month, another 2 year community college (Middlesex County College, Edison, New Jersey) , less than 25 miles away, opened its "Technical Services Center."

As reported by Anatonoff(1990), our homes will soon have "smart" TVs. He reports, "Matsushita is already testing a voice recognition interface that would allow you to change the channel on the TV, or program a VCR, by speaking into a wireless microphone." He explains that another user-friendly interface " ... under development in the laboratory features on-screen graphics resembling Apple Computer's Macintosh icons." O'Malley(1990) explains how digital music processing can artificially create music that imitates music from a live performance. "In a live performance you hear music in three stages : direct sound, early reflections, and late reflections, or reverberations. Although often separated by mere milliseconds, these distinct stages are the auditory hallmarks of live music." Digital sound processing allows us to create many special effects and will become a common commodity.

To improve our educational systems, we must address the availability of powerful technology. While we may not be able to afford the latest and greatest, technologies that are 2 or 3 years old are rapidly becoming more affordable.

Evolution

As the development of technology follows an accelerating evolutionary process, so has the use of technology by schools. It is accurate to say that the rate of education's evolution has not been able to keep pace with the development of technology. Luehrmann(1990) points out, "It took 20 years for the overhead projector to make its way from the bowling alley to the classroom. I'm optimistic. I'm beginning to see computers in bowling alleys."

The proper infusion of technology into education is an evolutionary process for three major reasons:

1. the development of technology itself is an evolutionary process
2. the cost of technology overburdens educational budgets
3. it takes time to implement programs and to provide inservice

The first reason simply makes the process of infusing technology into education dependent upon what's available.

The second reason is a reality that we must accept and contend with. Even in good economic times, it is difficult to allocate substantial amounts of funds for technology. In poor economic times, the problem is more critical. Long-range planning and wise-spending become essential. A few strategies that will help overcome the obstacle of costs include:

1. make acquisition of technology a high priority
2. consider this as on-going expense - not a 1 shot approach
3. put technology into the media center - where all student can utilize it
4. use grant monies
5. "pool" resources
6. develop partnerships with industry
7. take donations of used hardware from industry
8. take advantage of promotional programs - such as the supermarket "give-away" programs
9. be creative !!

An important aspect of the high cost of technology is to ensure that expenditures result in utilization. Equipment purchased must be used, otherwise there will be no support to fund additional expenditures.

The third reason, time, is very important and should not be overlooked. Having technology is one step, but inservice is important for the correct and appropriate use of the technology. While most newer technologies are becoming easier to operate, inservice is needed to infuse them in an effective manner. How to integrate the technology into the curriculum is more important than knowing how to operate the hardware. This aspect adds time and expense to the process. It is important to consider that many present educators received their training before the development of most of the technologies available at this time. Kinnaman(1990) quotes Dr. Seymour Papert, "... empowering teachers to be bold enough to think and be open to change. We can't create a new education without people who will do it."

To improve our educational systems, it is important to consider the use of technology as an evolutionary process. The term "evolution" implies: gradual, growth, change and a natural process. Realistically, the educational use of technology is evolving - we just need to speed up the process!

For Improved, Revitalized [illegible]ation

Considering the recognized needs in this technological age to gather, process, interpret and use information, this should be an exciting time in the area of educational leadership. New or revised curricula should include the use of appropriate technology and dealing with large amounts of readily-available information. Instruction needs to embrace the use of available technology and multi-media to provide lessons that are informative and exciting.

In this age of multi-media it is difficult for our students to get motivated to read in a mode that only contains printed characters. Nor are worksheets and note-taking sessions very stimulating. Mecklenburger(1990) offers the assessment, "Virtually every student-sized and classroom-sized application of information technology imaginable - from student-produced television to students using supercomputers, from teachers reducing their clerical burdens to teachers making fascinating electronic presentations - exists *somewhere* in America, and both the literature of education and the speeches on the convention circuits resound with the hope that more teachers, schools, school systems, and even states will elect to follow suit. Yet chalkboards, lectures, and textbooks continue to dominate instruction almost *everywhere*."

Mecklenburger(1990) further states, "Electronic learning makes feasible new patterns of organization other than the classroom. For example, networks of learners can be organized across town, across a region, or even around the world." Watson (1990), promoting the use of telecommunications, suggests that communicating with students in China or Russia is more interesting than going through books and encyclopedias. Mecklenburger(1990) further states, "Today, students and educators alike can create, receive, collect, and share data, text, images, and sounds on myriad topics in ways more stimulating, richer, and more timely than ever before - if they have access to the appropriate technology and the ability to use it."

Naisbitt (1985) adds, "When we make the old reliable basics the be-all and end-all of education, we reduce the three Rs to remedial, repetitious, and rote." He suggests that we give our young people TLC - thinking, learning, and creating. He explains, " In a world that is constantly changing, there is no one subject or set of subjects that will serve you for the foreseeable future, let alone for the rest of your life. The most important skill to acquire is learning how to learn." Furthermore, "If you know how to learn, you can adapt to change no matter what technological, social, or economic permutation occurs. If you know how to learn, you will not be completely devastated if, like many U.S. autoworkers, your job has moved overseas, or like many steelworkers, your equipment has grown obsolete."

Many studies proclaim that our educational systems need to be improved. This improvement includes making our instruction more interesting, more conceptual - process oriented, more of an on-going process, and more in line with student needs in our information-hungry society.

Now is the time to make strides in improving education. Now is the time to revitalize stagnant curricula and out-dated modes of instruction. With the help of technology, we can meet the needs of our students in this information-hungry society. Schools must provide the technology and training that our students need to process vast amounts of information as extensions of their bodies. And, inservice is needed to support these changes. Let's "light the fire " - the tools are ready for our use !!

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